ANALYSIS OF FRACTURE UNION IN INTRAMEDULLARY INTERLOCKING NAILING IN FRACTURE SHAFT OF FEMUR

Dissertation submitted In partial fulfilment of regulation
for the award of

M.S.degree in Orthopaedics
(Branch II)

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CERTIFICATE

Certified that this is the bonafide dissertation done by **Dr.P.RADHAKRISHNAN** and submitted in partial fulfillment of the requirements for the award of M.S.degree BranchII (ORTHOPAEDIC SURGERY) of The Tamilnadu Dr. M.G.R. Medical University, Chennai.

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DECLARATION

I solemnly declare that the dissertation titled **"ANALYSIS OF FRACTURE UNION IN INTRAMEDULLARY INTERLOCKING NAILING IN FRACTURE SHAFT OF FEMUR"** was done by me from 2007 onwards under the guidance and supervision of **Prof Dr. S.DHANDAPANI, M.S.(ORTHO),M.Ch.(ORTHO)**

This dissertation is submitted to the Tamilnadu Dr. MGR Medical University towards the partial fulfillment of the requirement for the award of MS Degree in Orthopaedics (Branch II).

Place : **Dr. P.RADHAKRISHNAN.**

Date :

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TABLE OF CONTENTS

INTRODUCTION

Fracture of the shaft of the femur is a major cause of morbidity and mortality in patients who sustain high energy trauma.Morbidity arises from limb shortening,malalignment, knee contracture, non union and complications of fracture care.Mortality is infrequent,but can result from ,fat embolism,adult respiratory distress syndrome or resultant multi-organ failure especially in the polytrauma patients .Both morbidity and mortality can be reduced by prompt reduction and internal fixation of the fracture .

Restoration of alignment,rotation and length, preservation of the blood supply to aid union and early rehabilitation of patient is the goal of treatment,by achieving the good union at the fracture site. The type and location of the fracture , the degree of communition , the age of the patient , patient's social and economic status and other factors may influence the method of treatment.

Currently intramedullary interlocking nailing is considered to be the treatment of choice for most of the femoral shaft fractures.

AIM AND OBJECTIVES OF THE STUDY

To analyse the fracture union in intramedullary interlocking nailing in fracture shaft of femur.

Our study involves analysis of fracture union in femoral shaft fractures in the influence of variables like age, open or closed interlocking nailing ,duration between injury and surgery, type of fracture .

REVIEW OF LITERATURE

Intramedullary fixation of fracture of long bones is one of the mode of treatment since 16 th century.Wooden pegs, ivory pegs and bones were used as intramedullary devices followed by metals.Earlier orthopaedic surgeons Koning,Hoagland,Lambotte and Heygroves used ivory and metal as intramedullary devices.

Successful intramedullary nailing began during world war-II with the work of Kuntscher. Kuntscher[17] and Moatz (1994) described intramedullary nailing of femur along with other bones like tibia, humerus, radius, and ulna. In early 1950's Livingston[22] and Modny came out with intramedullary device with slot all along their length for cross pinning with screws.In 1957, Kuntscher recommended reaming to achieve a uniform diameter for medullary canal for better fixation , extending the indications for intramedullary nailing for femur shaft , a little away from the isthumus.

Kaesmann[18] contributed the concept of compression nailing in 1966. The distal fragment was anchored to the nail through cross pins and fracture fragments compressed with a device anchored to the proximal end of the nail. In 1968 Kuntscher proposed a new device called the detensor nail for

communited fractures for achieving stability with transverse bolts, through prefabricated holes in the nail .

This started the era of interlocking nailing. J.Ender[18] introduced the use of multiple pre-bent flexible pins in 1970. In the early 1970s fluted intramedullary rods came into existence. It was designed for special torsional stability. In 1972 Klemn and Schellmann[16] improved on the nails and bolts, developed instumentation and standardised the operative techniques. In 1972 Grosse and Kempf in strasborg[17] , France developed G.K.nail for both femur and tibia and broadened the indications.

Winquest R.A., Clawson DK[36], concluded in their study that intramedullary interlocking nail acts as an load sharing implant, and has great torsional rigidity and rotational stability.

Robert J.Brumback, walter virkus[7] concluded in their study that All intramedullary nailing creates some loss of endosteal blood supply and an increase in intramedullary pressure, resulting in marrow embolization. In laboratory studies, both reamed and nonreamed intramedullary nailing have led to alteration in selected pulmonary variables. This effect, although transient, appeared more pronounced with reamed techniques than with nonreamed techniques. Concern about the systemic pulmonary effects of

reamed intramedullary nailing has led to an increase in the use of nonreamed nailing. The authors of most clinical studies have reported that reamed intramedullary nailing has not been associated with a concomitant increase in pulmonary complications in multiply injured patients, although this point is still controversial. Femoral shaft fractures treated with nonreamed nailing have been shown to have slightly higher rates of delayed union and nonunion compared with those treated with reamed nails. Reamed interlocking intramedullary fixation remains the treatment of choice for femoral shaft fractures in adults. Further study is required to determine whether an identifiable subgroup of trauma patients is adversely affected by intramedullary reaming, which would suggest the need for alternative fixation techniques.

Brumback et al [8] in his series, reported 92% union rate with average union time of 4.8 months in 100 case of closed interlocking nailing. Pati and Bansal et al [25] reported 85.87% union rate with average union time of 5.7 months in a study of 90 patient with open interlocking nailing.

Donald A wiss, William, W Brien[12] concluded in their series that closed interlocking nailing is treatment of choice for most segmental femoral fracture. Rinaldi et al 1989, Braten et al 1990 [26]in their study concluded that

there will be substantial soft tissue injury in segmental femoral fracture and on further open reduction decreases the union rate.

Gross et al[13] advised dynamisation in the 3rd - 5th post operative month if no radiological evidence of union present. Pagie.A., Whittle[23] in their series concluded bone grafting was necessary for winquest type III and type IV femoral shaft fracture to augment union. It justifies in our series in which winquest type III and type IV fracture (13.3%) were treated with autologous bone grafting.

Brumback et al[6] in his series advocated immediate weight bearing for allowing micro movements at fracture site which augments union and advised in all stable fracture partial weight bearing started at the end of 3rd week and full weight bearing allowed at the end of 6th week. For all communited fracture and segmental fracture parital and full weight bearing allowed at 6 week and 12 weeks respectively.

The Grosse-Kempf[13] concluded in his study, the locking transfixion screws afford additional axial and rotational stability and have expanded the use of intramedullary fixation to include all types of femoral fractures distal to the lesser trochanter and to within 7 cm of the knee joint. Stabilization of a femoral fracture within the first twenty-four hours. Instead of being confined

to bed in traction, patients can be mobilized on the first postoperative day. The expected union rate is between 95% and 99%, with infreque after the injury has been shown to reduce morbidity and mortality in multiply injured patients.

PD Hajek, HR Bicknell, WE Bronson, et. al.[14], studied about use of one distal screw instead of two distal screws in lower 1/3rd shaft fractures. No significant difference was found in the torsional rigidity or axial load to failure when one as opposed to two distal screws had been used. There were no non-unions or failures of the implant in his study.

SURGICAL ANATOMY

Femur is the longest, stongest, bone in the body. It takes part in both hip and knee articulation. Femur consists of three distinct parts, shaft or diaphysis, the proximal metaphysis consists of articular head, greater and lesser trochanters. Distal metaphysis is a bicondylar structure articulating with the tibia. The shaft extends from the level of trochanter to flare of the condyles.

SHAFT OF FEMUR:

Shaft is almost cylindrical through most of it's length.Prominent feature of the shaft is it's anterior curvature,magnitude of which is highly variable. It's long axis makes an angle of 7 degree with the vertical and diverges about 10 degree from long axis of tibia.The shaft is a cylindrical compact bone with a large medullary cavity.The wall is thick at the isthmus where the femur is narrowest and medullary cavity is less capacious. Proximally and distally the compact wall becomes progressively thinner .Correspondingly medullary cavity is trumpet shaped opening both proximally and distally. Cross section is almost circular except for the broad ridge linea aspera-running down in the middle of posterior surface of femur. Here cortical thickness is greatest to withstand the compressive forces concentrated due to anterior curvature of the shaft.

BORDERS AND SURFACES:-

Middle one-third of the shaft –three surfaces and three borders.The anterior surface which is smooth and convex lies between the lateral and medial borders, the lateral surface bounded behind by linea aspera and the medial surface is between an indistinct medial border and linea aspera. In distal 1/3 there is a posterior surface which lies between medial and lateral supra-condylar ridges.

COMPARTMENTS OF THIGH:-

Thigh contains three distinct facial compartments divided by medial, lateral and posterior intermuscular septae. The thick lateral intermuscular septum divides anterior and posterior compartments, while the thinner medial and posterior intermuscular septae seperates anterior from the medial and posterior compartment respectively.

Anterior Compartment:- It contains quadriceps femoris,ilio-psoas,pectineus and sartorius muscles. Neurovascular bundle consists of the femoral artery, vein, nerve and lateral femoral cutaneous nerve of thigh.

Medial Compartment:- The compartment consists of gracilis,adductor longus,adductor magnus,adductor brevis and obturator externus muscles.Neurovascular bundle consists of profunda femoris artery, obturator artery, vein and nerve.

Posterior Compartment:- Biceps femoris, semi-tendinosus, semi-membranosus , portion of adductor magnus with branches of the profounda femoris artery, sciatic nerve and posterior femoral cutaneous nerve of thigh form the contents of the posterior compartment.

MUSCULAR FORCES:-

The gluteal medius is inserted into greater trochanter and therefore in fracture distal to their insertion,it abducts the proximal fragment.Ilio-psoas although an internal rotator, tends to rotate externally because of change in the axis of rotation of fracture. Adductor muscles span most of the shaft and hence exert a strong axial and varus load to the bone.Distal shaft fracture tend to angle into flexion through the pull of gastrocnemius muscle.

BLOOD SUPPLY OF FEMUR:-

Femur has a rich vascular supply, mainly derived from the profunda femoris artery. Nutrient artery to the femur arises from the second perforting artery and enters the femur proximally and posteriorly along the linea aspera.

After perforating the cortex,nutrient vessel arborises proximally and distally to provide endosteal circulation to the shaft. Usually the endosteal arteries supplies the inner 2/3 to 3/4 of the cortices. Similarly small periosteal vessels enter the femur along the linea aspera.

They align themselves perpendicular to the cortical surface while a few align longitudinally along the periosteum. These vessels supply the outer 1/3 to 1/4 of the cortex. Inside the cortex , there are direct communications between periosteal vessels and endosteal vessels.

The normal flow is centrifugal, although some blood return to the large venous sinusoids of the medullary canal. After diaphyseal fracture, circulatory pattern is radically altered. In fracture displacement, endosteal flow is interrupted and periosteal vessels assume a dominant role till fracture healing.

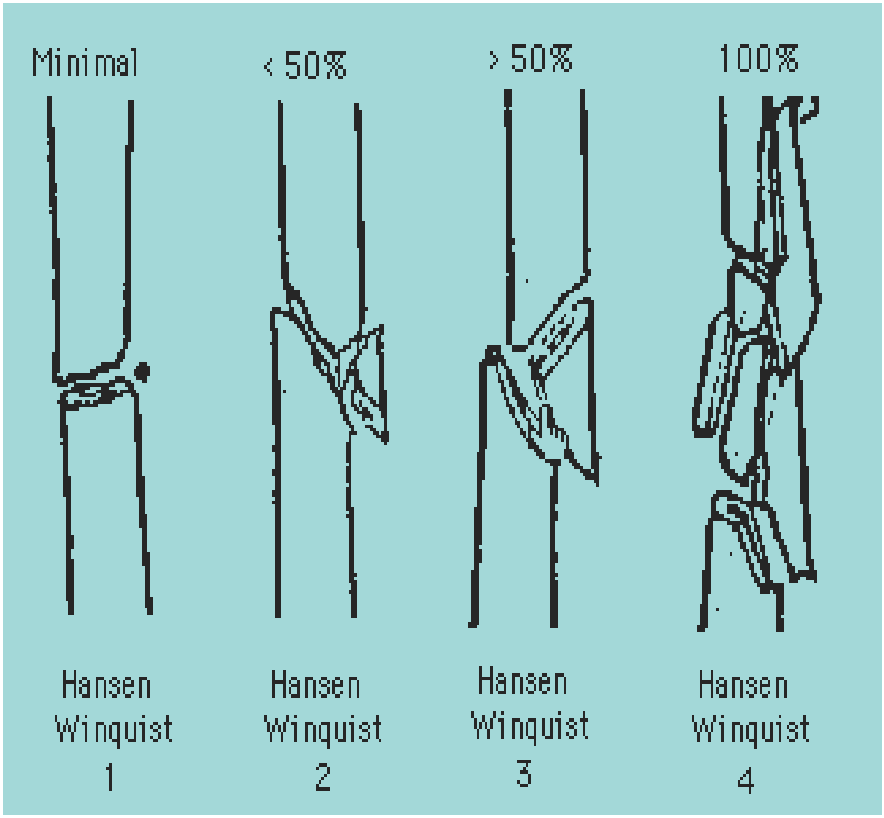
APPLIED ANATOMY:-

1) Straight tubular anatomy of femur is well suited for intra-medullary nail fixation.
2) Because high volume of thigh compartments, compartment syndrome is less frequent and therefore intra compartmental pressure monitoring is not essential always.

3) Traction device or fracture tables are necessary to counteract the deforming muscular forces to obtain a reduction
4) Muscular and gravitational forces contributing physiological loading needs intramedullary fixation.
5) Arrangements of compartments allows approach to anterior and posterior shaft through lateral incision and medial shaft requires a separate approach.
6) Most of the modern intramedullary implants are available in an average of 10-12mm high arch at their midpoint to accommodate anterior bowing.Otherwise gaping may occur at the posterior aspect.
7) During open reduction avoid soft tissue stripping and periosteal stripping to minimise damage to vascularity.

CLASSIFICATION

WINQUIST AND HANSEN'S CLASSIFICATION OF FRACTURE COMMUNITION:



WINQUIST AND HANSEN CLASSIFICATION:

Winquist's classification reflects the observation that the degrees of soft tissue damage and fracture instability increases with increasing grades of communition.

TYPE-1: There is only a tiny cortical fragment.

TYPE-2: The "butterfly fragment" is larger but there is still atleast 50% cortical contact between main fragments.

TYPE-3: The "butterfly fragment" involves more than 50% of bone width.

TYPE-4: It is essentially a segmental fracture.

BIOMECHANICS AND PRINCIPLES OF INTERLOCKING NAILING

Kuntscher introduced the principle of what he called elastic nailing and coined the term “elastic impingement” (radial compliance) to describe its mode of action. The nail which had a slot can be compressed during insertion into medullary canal .

Once insertion was complete the nail would expand and grip the endosteal surface of bone . Further biomechanical study[2] has shown that these nails are stable by three point bending rather than radial compliance . Contact also exists between the nail and the bone at the entry point and also the cancellous epiphyseal bone at distal end .(2)

Significant stress on the bone are generated just by activities of daily living . The bones are stressed as muscle contracts , bringing the origin and insertion close together to move joints . Bending of bone cause compression on concave side . Femur is subjected to compression , torsion and bending stress . An intact bone which is a stiff one , becomes unstable after a fracture .

An intramedullary nail acts as temporary splint until callus forms at fracture site . Finally mature bony callus forms restoring original stiffness .

The nail serves to stabilize the fracture fragments and maintain alignment and permits micromotion at fracture site during weight bearing .

The nail acts as an internal splint[10] and serves as a load sharing device permitting weight bearing across fracture sites and allows healing by peripheral callus . It allows axial loads to be transmitted to opposed ends of fracture fragments . The nails are best at controlled bending loads. They do not provide substantial resistance to axial loading or rotation unless additionally fixed with interlocking screws or pins .

MATERIAL PROPERTIES :

Material must be biocompatible and of sufficient strength to withstand stress and strain . Material strength depends on grain size , porosity and manufacturing process . Bigger the grain size and porosity lower the tensile strength .

316L stainless steel has molybdenum and reduced carbon content for maximum corrosion resistance . Titanium alloys have excellent resistance and fatigue strength but poor tensile strength. Polymeric implants have higher tensile strength , modulus of elasticity and hardness but poor wear properties[25] .

INTERLOCKING NAILS :

The standard non locked nail is useful in treatment of simple and minimally communited mid shaft fractures of femur and tibia . In selected cases early mobility and weight bearing can be allowed . However interlocking nail has made non-locking nail obsolete .

STATIC LOCKING AND BRIDGING FIXATION :

Screw fixation at two ends of the nail interlock it with the proximal and distal fragments . This technique prevents sliding of these fragments along the nail and is called static nailing . Interlocking maintains bone length and rotation of the fragments but mainly improves the rotational stability of nail- bone construct . Static locking achieves bridging fixation .

In the presence of severe communition it is undesirable to open the fracture site and handle individual fragments to achieve alignment as further devascularisation occurs and the risk of nonunion increases .

In bridging fixation the implant extends across the zone of soft tssue injury and fracture ,but is fixed to major bone fragments proximal and distal to the injury site . Static locking results in creditable fracture healing . Static locking is used in fixation of segmental, communited , long oblique or spiral

fracture and in stabilization of fractures with the bone loss or pseudo-arthrosis [8,9,11].

DYNAMIC LOCKING :

When screws are inserted only at one end of the nail , the fixation is called dynamic locking . Dynamic locking is effective only when contact between the two major fragments is atleast 50% of cortical circumference . Dynamic locking fails in the presence of unstable bone contact between the main fragments . The unlocked end of the nail attains fixation in the splinting mode as it snuggly fits in the reamed diaphyseal medullary canal[3] .

DYNAMISATION:

Removing the screws from the longer fragment maintaining adequate control of the shorter fragment is called dynamisation . If the healing is progressing normally , there is no need to dynamise . If the consolidation is continuing well , removal of static screw will not improve the quality of callus .

It is not a standard practice to dynamise as it weakens the interlocking nail assembly . Dynamisation is indicated when there is risk of development of non-union or in pseudo arthrosis . Premature removal of locking screws may cause shortening , instability [15].

NAIL DESIGN :

The geometry of an intra medullary nail is responsible for its strength , rigidity, and fixation with the bone. The major geometric features are longitudinal (anterior) bow, cross sectional shape, transerverse diameter , slot characteristics, material property and structural stiffness .

The femoral nails were originally designed as a straight nail . In the last decades , femoral nails have been manufactured with slight curve (with a radius of curvature of 3.5 meters) to conferm to the slight anterior curvature of femur. A partially slotted nail is flexible and accommodates some variation in insertion points to certain extent . A non-slotted nail , being less flexible, must be introduced through a precise point of insertion , failing which there is an increased risk of incarceration .

The non-slotted nail bone construct is more stable than partially slotted nail bone fixation in torsion and thus prevents shear stress generation at the fracture site . Absence of shear stress improves fracture healing . Bending rigidity of nail can be altered by varying the thickness of its wall. Thus a thicker walled slotted nail will have similar rigidity to a thinner walled non-slotted nail .

A non-slotted nail[11] can be made into a smaller diameter yet have adequate strength . This possibility has led to the development of a non slotted , locked intramedullary nail which may be cannulated or solid .

LENGTH AND WORKING LENGTH :

The nail length is considered from three new points :

1) Total nail length
2) Length of nail-bone contact
3) Working length

Total nail length depends on anatomical considerations. Too long a nail protrude insertion site causing pain and limitation of motion . Too short nail can compromise the fixation .

The length of nail-bone contact reflects total surface area of contact between nail and bone . The larger the contact area , the higher the resistance to motion .

Working length is defined as length of the nail spanning the fracture site from its distal point of fixation in the proximal fragment to its proximal point of fixation in the distal fragment . Thus working length is unsupported

portion of nail in between two major bone fragments and reflects the length of nail carrying majority of load across fracture site .

The bending stiffness of a nail is inversely proportional to square of its working length , while torsional stiffness is inversely proportional to its working length . Shorter working length means stronger fixation . Weight bearing with an interlocked nail improves nail-bone contact as the nail bends under axial load and increases nail-bone contact at fracture site reducing the working length and adding over all stiffness of fixation.

LOCKING SCREWS :

Strength depends on diameter and the span of screws between supporting points. The distal locking screw is loaded in four point bending as axial load is applied during walking . The screw ends are supported by cortices.

Thus increased span decreases the strength. Screws which have threaded portion at one end are stronger than fully threaded ones. Oblique orientation of locking nail hole prevents the mediolateral translation in varus-valgus bending. It is must that two locking screws are used when distal fragment is short to avoid instability in sagittal plane .

FRACTURE HEALING WITH MEDULLARY NAILING

Stability has mechanical basis and vascularity has biological basis of uncomplicated fracture healing . Union in a fracture treated by medullary nailing is almost always peripheral. Periosteum is almost always injured by the fracture and despite care further insult occurs to periosteal vascularityif fragment ends are stripped during open reduction . Reaming of canal and nail insertion destroys blood supply of inner 2/3 of cortex for entire length . The damage to this blood supply and presence of nail, prevent formation of endosteal callus . Thus , the cortical bone ends may be avascular for varying distances .

Therefore union depends on bone formation within fracture haematoma , uniting periosteal callus of the fragments to produce peripheral union . If the nail is loose , bone formation in fracture hematoma occurs peripherally through the process of endochondral ossification . As haematoma organizes , fibroblastic cells differentiate to form a cartilaginous bridge between the periosteal callus of fragments .

If motion is excessive non union occurs . If motion is less union may only be delayed . If nail is tight periosteal callus is limited to a area near fracture . If no motion occurs , as in case of interlocking nailing abundant

capillaries form in organizing haematoma and new bone formation will be going through the cartilaginous stage , thus fracture unites more rapidly .

Barry L. Reimer et al[3] . suggested the following indications for bone grafting :

1. Comminuted fracture
2. Cortical defect > 1/3 of circumference
3. Persistent gap in follow up
4. Potentially unstable fixation
5. Devitalised fracture fragment

PRINCIPLES OF FRACTURE FIXATION BY INTERLOCKING NAIL

Interlocking nail is a safe method of fracture treatment,fixing the fracture so firmly that soft tissues and joints can be mobilised if atleast 50% of cortical circumferential contact between the main fracture fragment.The ultimate advantage is early mobilization with support[31,30].

1. Interlocking nailing of fracture is possible in any kind of diaphyseal fracture and proximal and distal fractures except for distal 1/5th of femur fracture which requires retrograde nail[10,2,30].

2. Nail of suitable length and diameter should be available and identified before surgery.
3. Suitable instruments, trained assistants, optimal theatre conditions are necessary for successful nailing.
4. Nail is not a substitute for bone union.
5. Closed nailing should be used wherever possible.

MEDULLARY NAILS CAN BE DIVIDED INTO

1. Reamed nails
2. Unreamed nails

Depends upon whether enlargement of the medullary canal is an intended part of nail insertion[22].

UNREAMED NAILS:

Flexible - Ender's nail, hackenthal nail,rush pins

Stiff - Lotter's nail,solid IL nails[20]

Advantages:

Simple and quick insertion

Less mechanical disruption of medullary blood supply.

Less infection rate.

Disadvantage:

Only smaller size nails can be used.

REAMED NAILS:

Locking	-	Gross kempf,Russel Taylor,AO nail and etc.
Non locking	-	Kuntscher nail, AO nail and etc.

Advantages:

- Allows insertion of larger sized implant improves nail bone contact across the working length of the implant.Directs the fracture fragment to more anatomical position.

- Factors which promote mitosis of osteogenic stem cells are at are deposited in fracture haematoma induces union[17]during reaming.

Disadvantage:

- Improper eccentric reaming may cause mal reduction.
- Reaming should be done in antegrade manner.
- Destroys medullary blood vessels and this may delay healing.
- Higher infection rates especially in open fracture
- Increased risk of fat embolism.
- Cortical thinning and fracture communition.
- Technically demanding.
- Equipment and inventory are costly.

EFFECTS OF REAMING ON DIAPHYSEAL CIRCULATION:

Rhinelander and his co-workers have studied the effect of reaming which has a theoretical disadvantage of preventing restoration of endosteal flow.Cylindrical and tubular nails thus completely fill the canal have a deleterious effect on restoration of endosteal flow.

Cloverleaf, fluted, flanged nails and other nails provide a potential space that allows restoration of endosteal flow in 4-8 weeks.The devascularisation is augmented by reaming for a large diameter nail,which leaves a layer of necrotic tissue.Till revascularisation,the dead cortical bone in unable to participate in healing process and is a large potential source for infection.However the intramedulary position of nail does not appear to hamper restoration of endosteal flow.

Clinical significance of snow fluffy pulmonary emboli that occurs during passage of reamer is not known especially in patients with uninjured lung. But this may have effects in patients with previously compromised pulmonary function.

Decrease in torsional strength especially after reaming of medullary canal to 12mm is upto 37% and with reaming to15mm reduces to 63%.

CLOSED AND OPEN NAILING:

A nail may be inserted by the closed or open method.In the closed method, fluoroscopy is used to achieve fracture Reduction. nail is inserted from a small opening distant from the fracture site in ante-grade manner.

Advantage of closed nailing:

- Less blood loss and less tissue trauma.
- Fracture haematoma not disturbed.
- Reduces risk of infection.
- Maintains periosteal blood supply.
- Earlier healing since no interference with soft tissue and vascularity in communited fractures.

Open method is resorted when there is incarceration of a small communited cortical fragment in the medullary canal and failure to obtain satisfactory fracture reduction by closed method.

Advantage of open nailing:

- Anatomical alignment of fracture .
- Image control not necessary.

Disadvantage of open nailing:

- Increased rate of infection.
- Increased incidence of non union.

NAIL REMOVAL:

From mechanical point of view it is not necessary to remove a nail in a weight bearing limb and unlike a plate, it may be left definitely in the body. The removal initiated by patient request should be delayed for 18 months. Local pain, swelling secondary backing out of the implant are other indications for removal. Bony union on radiological examination is a prerequisite for such a removal[37].

Difficult situations in nail removal:

1. **Extraction hook fails to hold[4,7]:**

   Stack the canal around the hook with ball tipped guide wires. Grasp the bunch in a wide grip and hammer out to remove the nail.

2. **Bone growth along the track of the locking screws removed long ago:** Redrill the holes with a suitable large drill bit.

3. **Broken nail in a united fracture:**

   Remove proximal half of the nail. Pass a ball tipped guide wire into the proximal canal until is near the broken end of the nail. Ream the proximal upto the broken end of the nail to facilitate easy removal. Pass two or more guide wires into the distal nail fragment and impact them with a hammer. Grasp the bunch in a nice grip and hammer out to remove the nail.

4. **Broken solid nail in an united fracture implant is stable**

   Remove the proximal half. Create a window in the bone distal to the tip of nail and hammer the nail out of femur through the the knee joint .

5. **Protruding nail in a healed fracture doesnot move**.

   Use specialized metal cutting equipment to remove the offending length of the nail.

6. **Impacted nail:**

   Identify the point of maximum hold under fluoroscopy. Make a longitudinal cut in the bone with an oscillating saw or an osteotome at the point. Extend the cut either way till the bone spring open enough to allow nail removal.

7. Removal of bent nail:

Manual straightening of the bent nail should be attempted first and nail can be removed through proximal part using nail extractor. If it is not possible, exposure of the fracture site and cut nail with saw, proximal and distal part can be removed as broken nail extraction technique.

Preoperative short wave diathermy for 2weeks does play a role in loosening of the nail in medullary canal.

MATERIALS & METHODS

Materials for this study

A prospective study of interlocking nailing for diaphyseal fracture of femur was conducted from SEP 2007 to SEP 2009 in 60 cases at Coimbatore Medical College Hospital, Coimbatore .

INCLUSION CRITERIA

- 18 year to 86 years of age
- all closed femoral shaft fracture distal to lesser trochanter and up to distal 1\5th femoral shaft
- Gustilo Anderson grade I and II open fracture

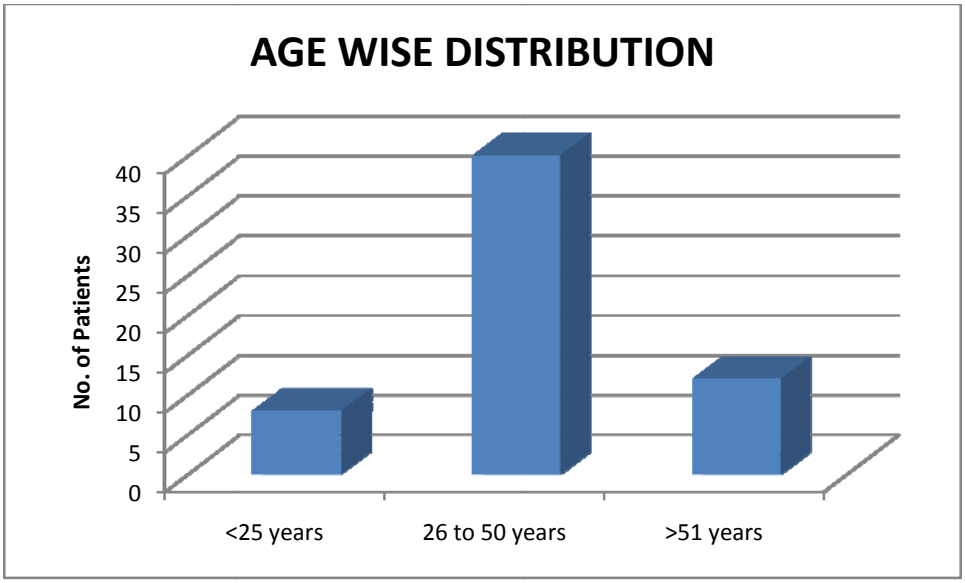
EXCLUSION CRITERIA

- Age less than 18 years and more than 86 years
- Gustilo Anderson grade III open fracture
- Pregnant women

AGE DISTRIBUTION :

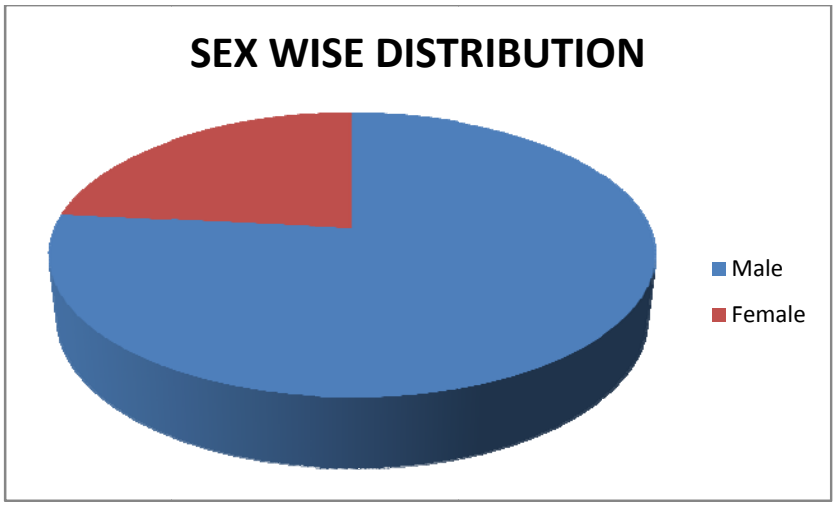
Patient fall under age group of 18 years to 86 years with mean age of 34 years .

Age Group	No. of Patients
<25 years	8
26 to 50 years	40
>51 years	12
TOTAL	60



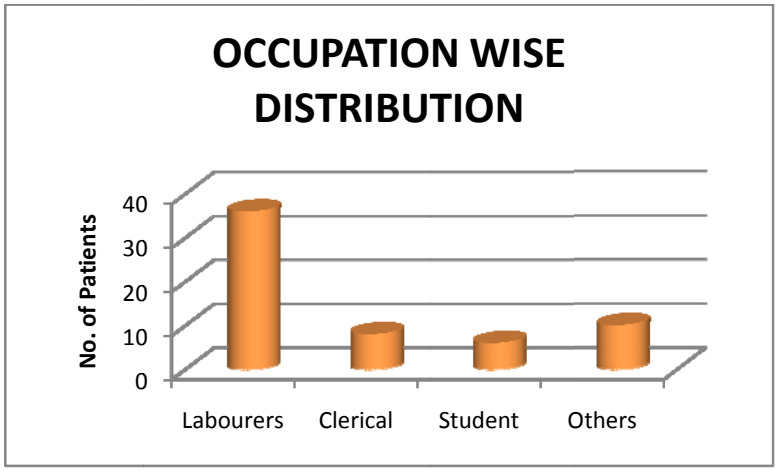
SEX DISTRIBUTION:

Male	46
Female	14
TOTAL	60



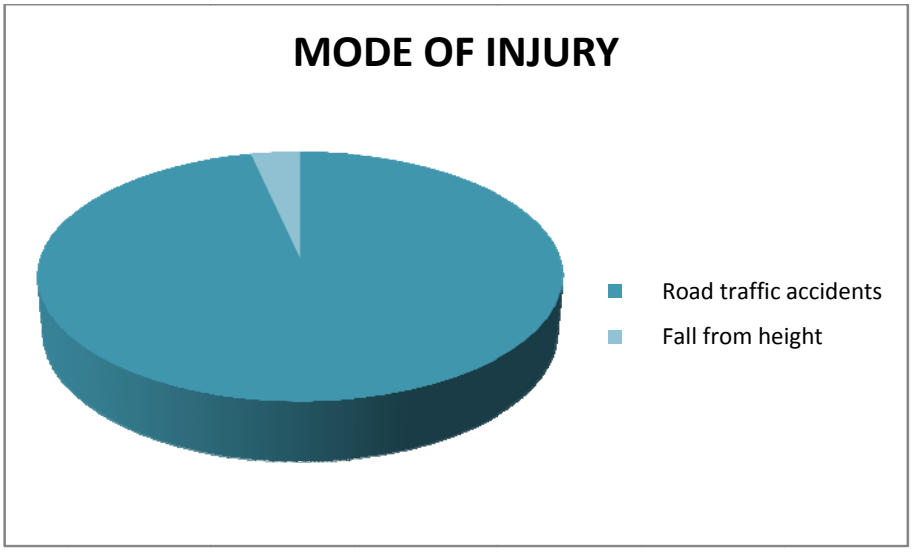
OCCUPATION:

Occupation	No. of Patients
Labourers	36
Clerical	8
Student	6
Others	10



MODE OF INJURY :

Mode of Injury	No. of Patients
Road traffic accidents	56
Fall from height	2



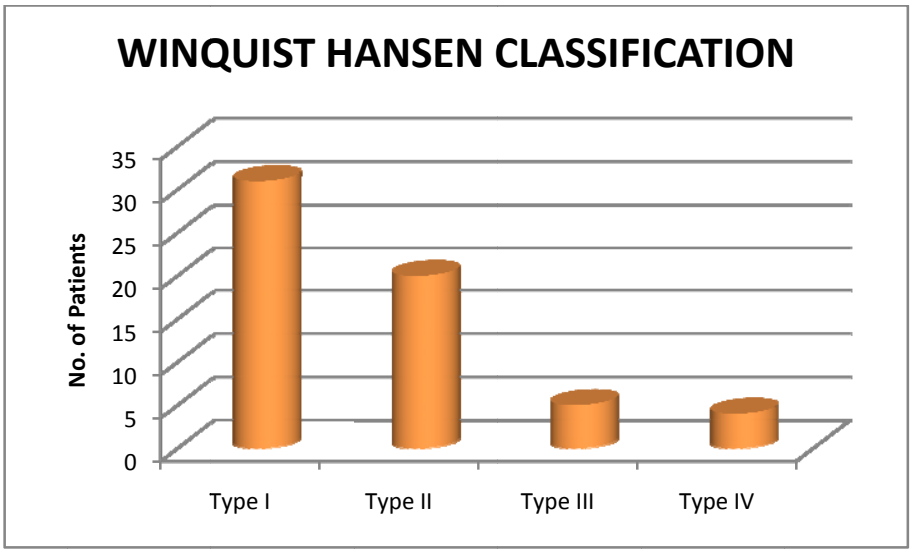
SIDE INVOLVED :

Right side	36
Left side	24

CLASSIFICATION

Winquest Hansen-Diaphyseal communition

Classification	No. of Patients
Type I	31
Type II	20
Type III	5
Type IV	4

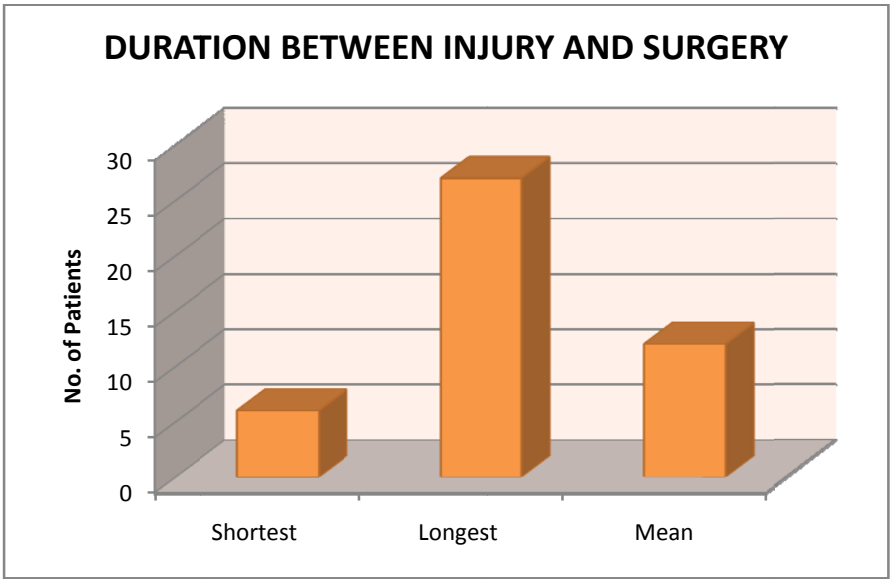


TYPE OF INJURY:

Open	2
Closed	58

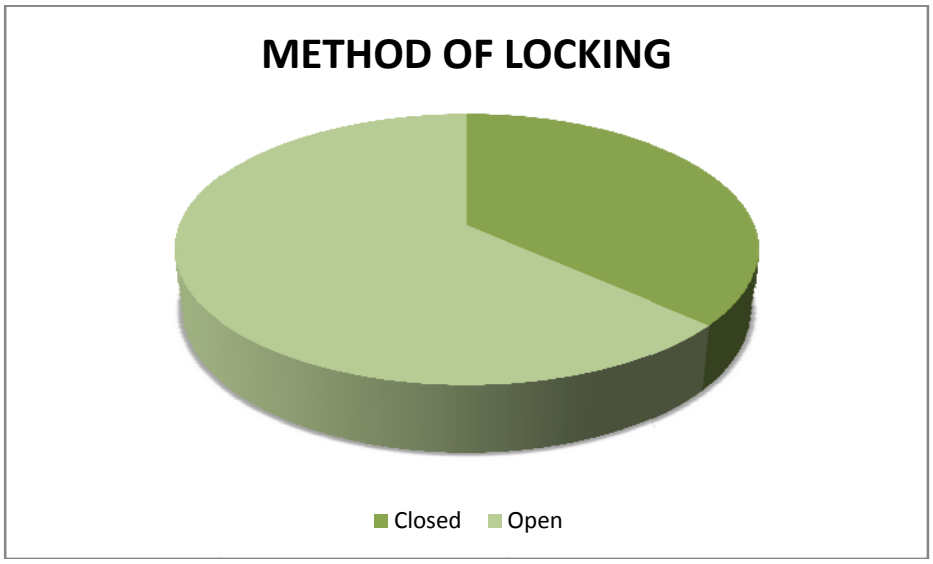
DURATION BETWEEN INJURY AND SURGERY:

Duration	No. of Patients
Shortest	6
Longest	27
Mean	12



METHOD OF NAILING :

Closed	22
Open	38



LOCKING

Static	54
Dynamic	2

MEDULLARY REAMING :

Reamed	58
Unreamed	2

BONE GRAFTING PROCEDURE :

Interlocking nailing alone	46
Interlocking nailing + Bone grafting	6
Bone grafting later on	2

DURATION OF HOSPITAL STAY :

Shortest	14
Longest	34
Mean	16

METHODS

PRE-OPERATIVE MANAGEMENT:

Patient with fracture shaft of femur may be in hypovolemic shock requiring blood transfusion and fluid replacement.Since associated injuries are known to occur, involvements of other specialities may be required.

After the patient has been stabilized,in skeletal traction in the form of upper tibial pin traction on a Bohler – Braun splint with a weight of 10% of patient body weight is added.This traction reduces unnecessary intra-operative stripping of fragments to reduce the fracture, to prevent soft tissue contracture and maintain the limb length.

IMPLANT SELECTION

In our study we have used conventional interlocking nail.The proper length of the nail used was determined by measuring on the normal side from the tip of the greater trochanter to superior pole of the patella.Diameter of the nail was measured at the isthmic level on the x-ray.

Best method of measuring the length is by scanogram.A nail of known length is strapped to the lateral side of the normal thigh.Then antero-posterior roentgenograms are made to measure the nail size[36].

INSTRUMENTS

Regadless of which type of nail is used, a full set of nail length and sizes must be available for surgery.Femoral interlocking nails are available in length from 34 to 44cms.All the associated instruments for insertion of the nail as well as extraction of the nail are mandatory.Image intensifier is mandatory to do closed nailing and distal locking.

ANAESTHESIA:

Epidural or spinal anaesthesia.

POSITION:

Patient is positioned laterally on a ordinary table with suitable sand bags and pillows.

In Fracture table with patient in supine position with traction of involved limbs and abduction of normal limb to allow navigation of image intensifier.

ENTRY POINT:

By 5cms gluteal incisions starting from top of the greater trochanter,gluteal medius split in the middle and pyriform fossa exposed.Using awl medullary canal is opened and circular hole is made.

REAMING AND FRACTURE REDUCTION:

Serial reaming done with rigid reamer or flexible reamers upto desired size of the nail and it should cross the isthumus.Fracture site is exposed by postero-lateral approach,thus minimizing damage to the quadriceps musculature.

Trial reduction done and guide wire passed ante-gradely into proximal and distal fragments. Estimated nail length is chosen and the alignment of nail holes with the mechanical targeting system is verified.

NAIL INSERTION:

Nail is inserted in ante-grade manner over the guide wire by gentle taping.

DISTAL LOCKING:

With the help of distal targeting device, distal locking is done. If distal targeting device is not available, the locking done by free hand technique

using image intensifier. the fracture gap is impacted by gentle reverse hammering.

PROXIMAL LOCKING:

Proximal locking is done with the help of proximal targeting device.

BONE GRAFTING:

Autologous cancellous bone graft is harvested from iliac crest is packeded around the fracture site in winquest type III and IV communited fracture.

POST-OPERATIVE:

Parentral antibiotics were given for 3days,then converted into oral antibiotics for 7days.Suture removal done in 12-14 days.

MOBILISATION:

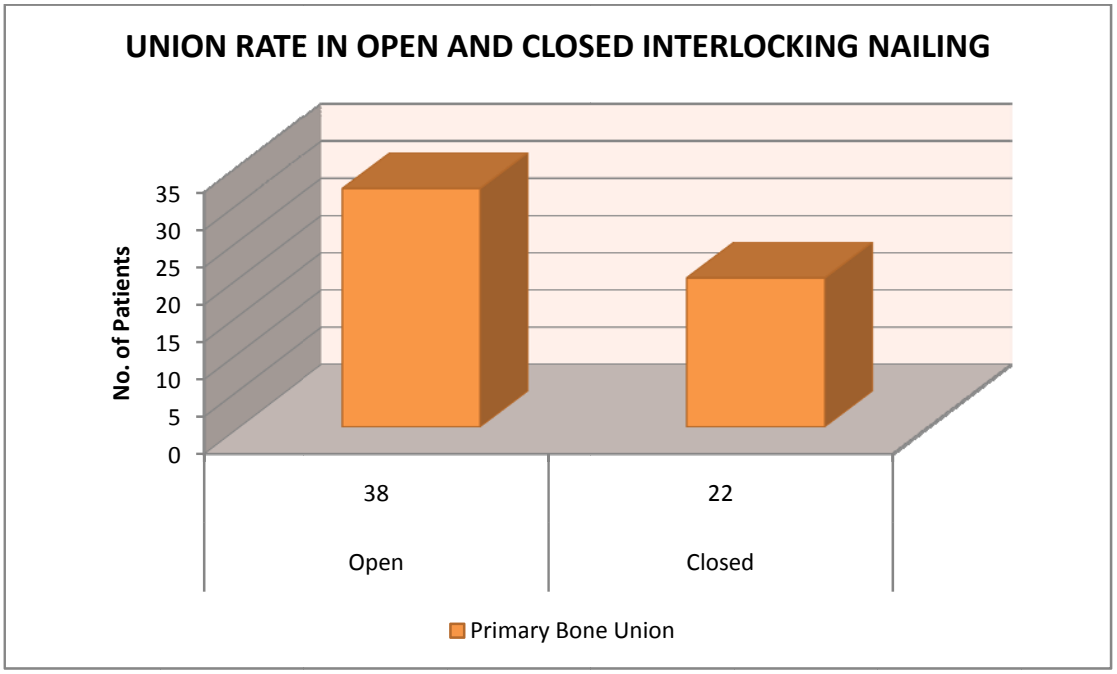
Quadriceps and hamstring strengthening exercises should be practised as soon as possible. These exercises are important to maintain muscle tone and strength and allow micro movement at fracture site, stimulate local vascularity, callus and subsequent union.

Knee mobilisation started on 3rd day after removal of drain. non weight bearing mobilization was started at the end of the 2nd week. In case of simple transverse fracture patient was allowed to bear weight at the end of the 3rd week and full weight bearing was allowed at the end of 6th week. In case of segmental and communited facture patient was allowed to bear partial weight at the end of 6th week after evidence of bridging callus and full weight bearing was allowed after 12weeks without support[38].

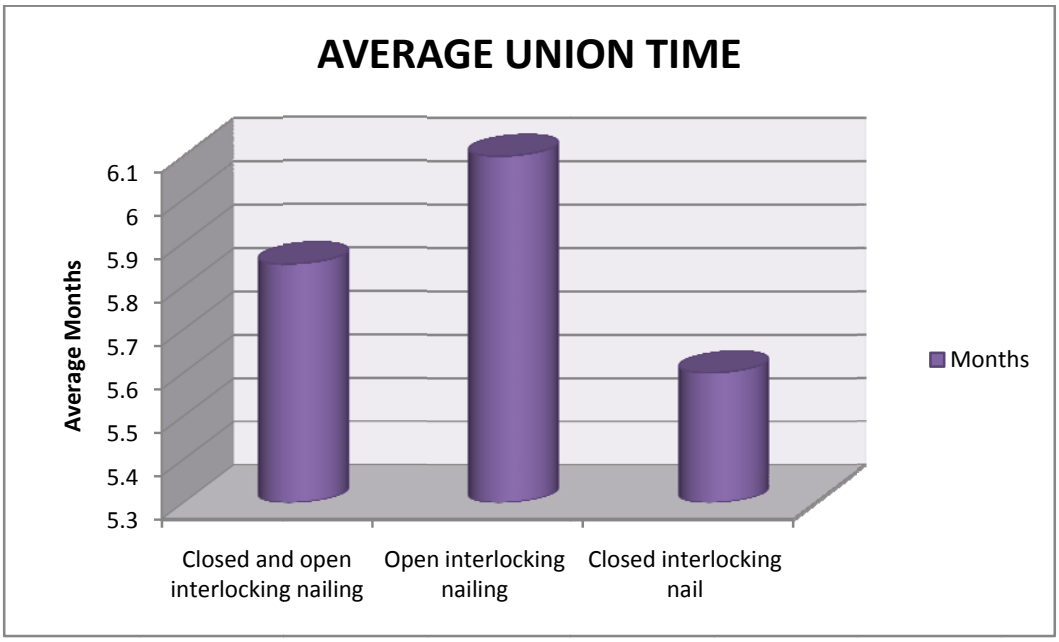
RESULTS

In our study, Male to Female ratio was 3.2:1 and 67% patients were in the 3rd to 5th decades. The mode of injury in 93% cases was road traffic accident. Two cases were open fractures.

The union rate was 85% in the open interlocking nailing and 91% in closed interlocking nailing.



The average union time including closed and open interlocking nailing was 5.85 months. The average union time in open interlocking nailing was 6.1 months (4 months to 9 months).The average union time in closed interlocking nail was 5.6 months (3 months to 7 months).



The average time duration between injury and surgery was 6.95 days in age group less than 25, 13.45 days in 25-50 age group and 15.6 days in age group more than 50. The average union time was 4.32 months in less than 25 age group, 5.85 in 25-50 age group and 7.42 months in age group more than 50. The average union time was 4.1 months in Type I, 4.8 months in Type II, 6.7 Months in Type III and 7.8 months in Type IV classification.

Late interventions were done in 4 cases of open nailing for delayed union. Bone grafting was done in two cases. Dynamisation was done in 2 cases and union achieved in these patients after another 3.5 months(3 months to 6 months).

delayed internvetion were done in 2 cases of closed interlocking nailing who had delayed union. Dynamisation was done in these two cases. Union was achieve after another 3 months (3 Months to 5 Months)

In two open interlocking cases nail was broken due to non union. In one patient exchange nailing with bone grafting was done. In another one patient nail was broken away from the fracture site hence dynamisation done leaving nail insitu. Post operatively plaster of paris cast applied.

Most of our patients had full range of knee and hip movements. Four patients had severe knee stiffness now on physiotherapy. Two patients had deep infection. Exploration, debridement and Irrigation done., infection was controlled with IV antibiotic

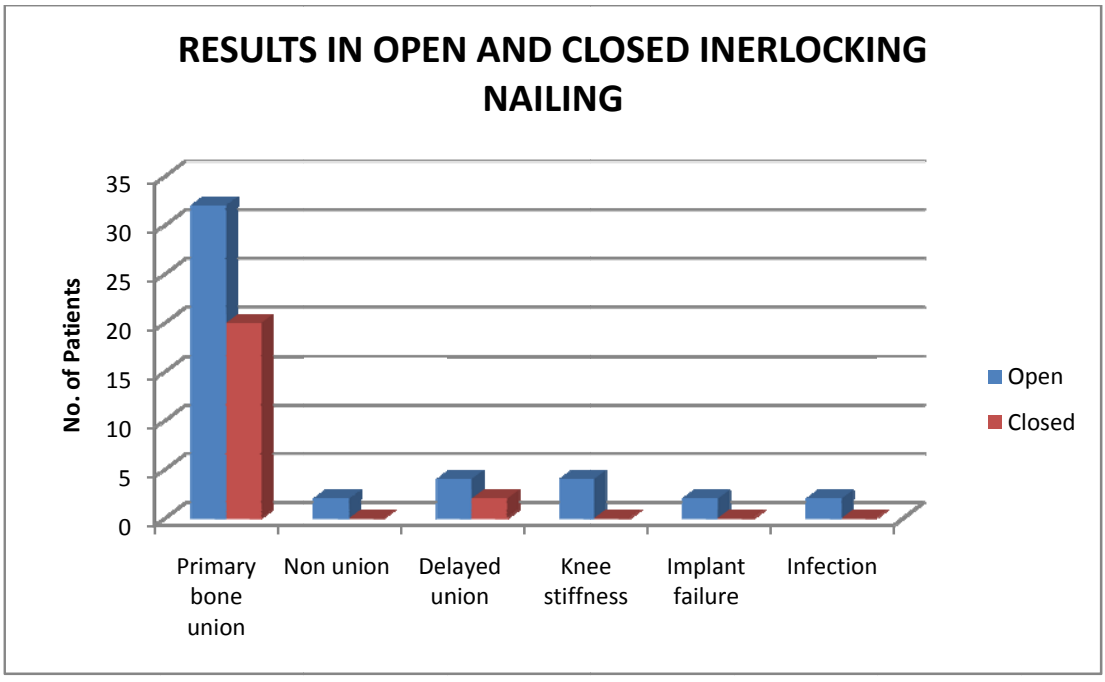
The clinico radiological evaluation done for each patient and the final observation were made according to the criteria by Thoresen et al[32]. There was excellent Result in 80% cases, good result in 13% cases, Fair in 3.3% cases.

SCORING SYSTEM FOR THE RESULT OF TREATMENT
(THORESEN B.O.et .al [32] .)

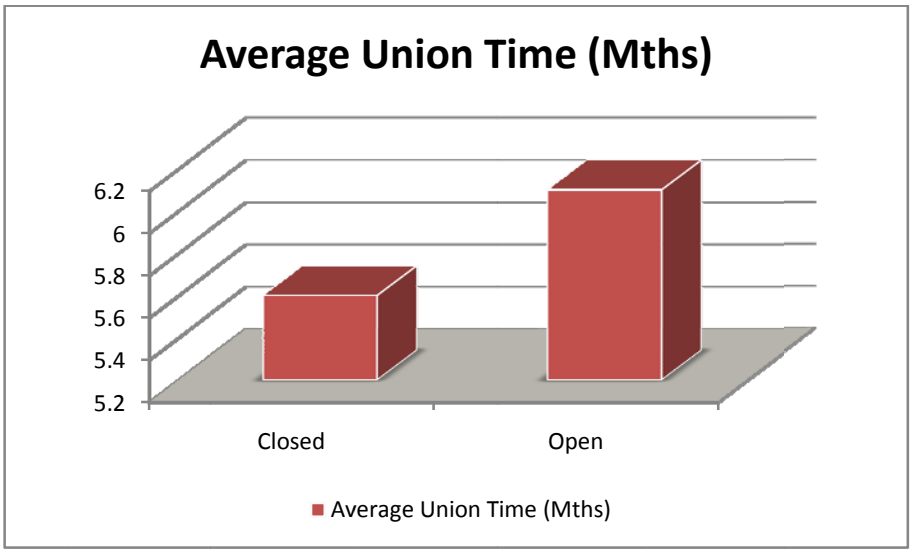
	RESULTS			
	Excellent	Good	Fair	Poor
MALALIGNMENT OF FEMUR				
Varus\ Valgus	5^0	5^0	1^0	$>10^0$
Antecurvatum\Recurvatum	5^0	10^0	15^0	$>15^0$
Internal rotation	5^0	10^0	15^0	$>15^0$
External rotation	10^0	15^0	20^0	$>20^0$
Shortening of femur in cm	1	2	3	>3
RANGE OF MOVEMENTS OF KNEE				
Flexion	$>120^0$	120^0	$90\text{-}120^0$	$<90^0$
Extension deficit	5^0	10^0	15^0	$>15^0$
Pain or swelling	None	Sporadic	Significant	Severe

RESULTS

	Interlocking nailing	
	open	closed
Primary bone union	32	20
Delayed union	4	2
Malunion	0	0
Angulation	0	0
Malrotation	0	0
Shortening >2 cm	0	0
Knee stiffness	4	0
Implant failure and non union	2	0
Proximal migration of nail	0	0
Infection	2	0
Lost follow up	0	0

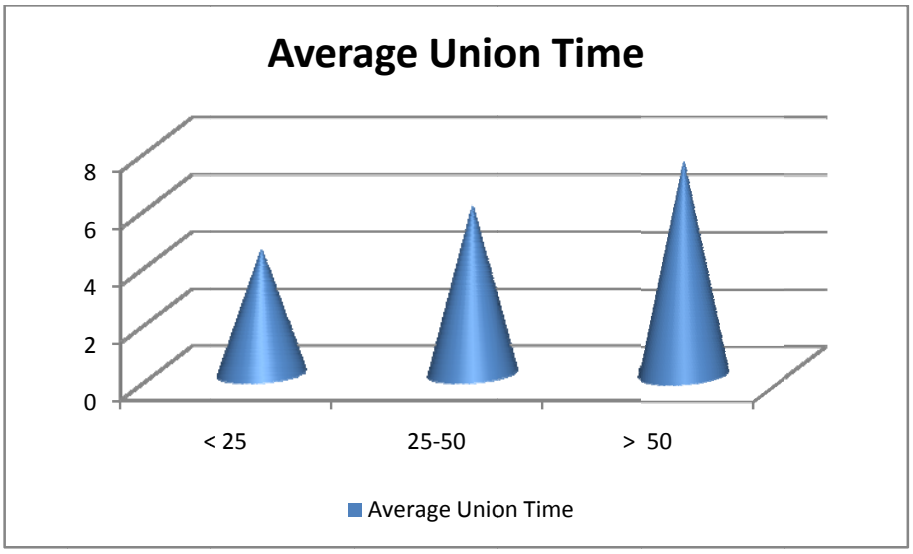


Interlocking Nailing	Average Union Time
Closed	5.6 Months
Open	6.1 Months

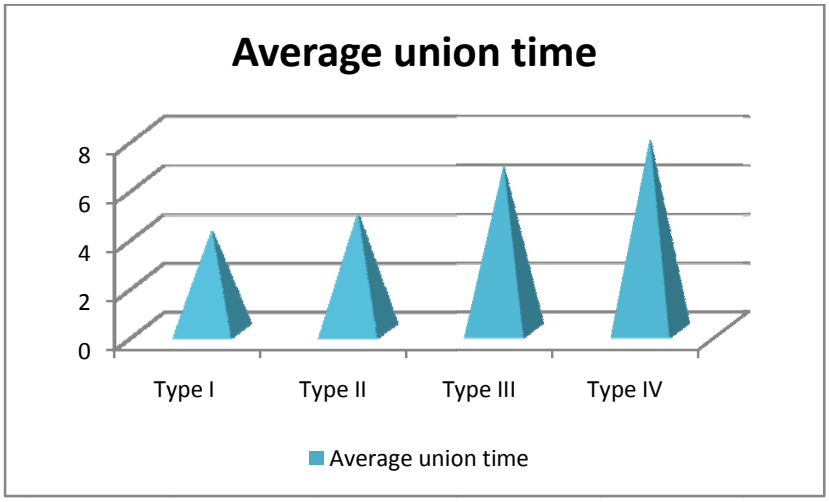


AVERAGE UNION TIME AGE GROUP WISE

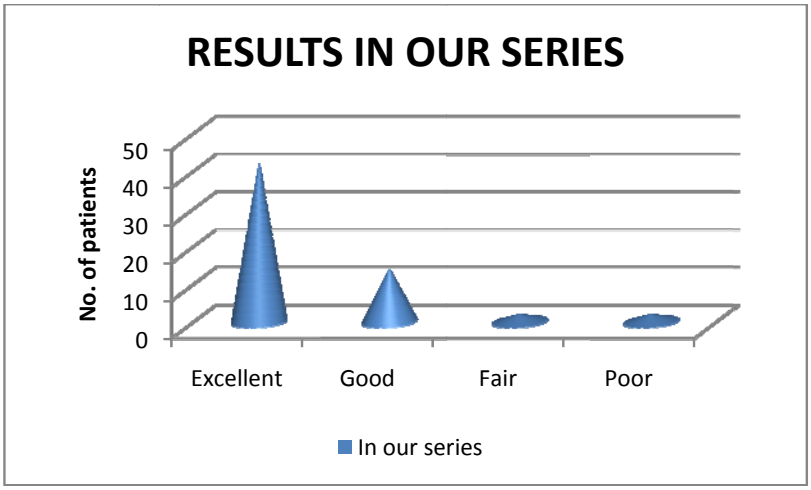
Age	Average Union Time
< 25	4.32 Months
25-50	5.85 Months
> 50	7.42 Months



Type of Fracture	Average union time
Type I	4.1 Months
Type II	4.8 Months
Type III	6.7 Months
Type IV	7.8 Months



FINAL RESULTS	In our series
Excellent	42
Good	14
Fair	2
Poor	2



OBSERVATION :

- 66.6% of patients were in age group of 26 to 50 years
- Average age of incidence was 35 years
- 60% of patients were male
- Right side predominantly involved in 76.6% of cases
- 96% of patient had closed injury
- 93% of cases had high velocity injuries
- 70 % of cases had been operated by open method
- Mean duration between injury and surgery was 12 days
- 13.3% of patients had autlogous bone grafting
- 96.6% of patients had static interlocking nailing
- 91% of primary bone union achieved in closed interlocking nailing.
- 85% of primary bone union achieved in open interlocking nailing.
- 96.6% of over all union rate was achieved after dynamisation and bone grafting for delayed union.
- The average union time in open interlocking nailing was 6.7 months (4 months to 9 months).The average union time in closed interlocking nail was 5.6 months (3 months to 7 months).
- The average union time including closed and open interlocking nailing was 5.85 months (3 months to 9 months).

DISCUSSION

Intramedullary interlocking nailing has been proved to be an effective method among the available methods of Treatment for femoral shaft fractures in adults. Winquest R.A., Clawson DK[36], concluded in their study that intramedullary interlocking nail acts as an load sharing implant, and has great torsional rigidity and rotational stability.

Robert J.Brumback, walter virkus[7] concluded in their study that femoral shaft fractures treated with undreamed nailing have been shown to have slightly higher rate of delayed union and non union compared with those of reamed nail. Reamed interlocking nail remains the treatment of choice for femoral shaft fracture in adults., since femoral shaft has rich periosteal blood supply reaming does not impede fracture healing. In our study we rountinely perform reamed interlocking nailing except in two open fracture cases.

Brumback et al [8] in his series, reported 92% union rate with average union time of 4.8 months in 100 case of closed interlocking nailing. In our series union rate was 91% with average union time of 5.6 months.

Pati and Bansal et al [25] reported 85.87% union rate with average union time of 5.7 months in a study of 90 patient with open interlocking nailing. In

our study of union rate was 85% with average union time of 6.1 months in open interlocking nailing. The poor result in open interlocking nailing attributed to disturbance of fracture haematoma and periosteal stripping in open interlocking nailing. In our study mean duration between injury and surgery was 12 days due to delay in patient reporting to hospital after native treatment, non availability of theatre time and associated co-morbid illness. This results in delay in taking up for surgery and difficulty in closed reduction ending in open interlocking nailing.

Covey, Claiborne A, Christian[10,11] in their study reported average union time of 3.97 months in < 25 age group 4.67 in 25 to 50 age group 6.87 months in > 50 age group. In our study in all age groups the average union time is more because of longer duration between injury and surgery.

Kettek[14], Mattz W [20] in their study reported the average union time of 3.72 months in type I fracture, 4.03 months in Type II fracture, 5.68 months in Type III and 6.2 months in Type IV. In our study the average union time is more because of open surgery and longer duration between injury and surgery

Donald A wiss, William, W Brien[12] concluded in their series that closed interlocking nailing is treatment of choice for most segmental femoral

fracture. Rinaldi et al 1989, Braten et al 1990 [26]in their study concluded that there will be substantial soft tissue injury in segmental femoral fracture and on further open reduction decreases the union rate. In our study segmental femoral fracture(15%) were fixed with closed static interlocking nailing. we performed open interlocking nailing with bone grafting in two cases due to delay in taking up for surgery.

Gross et al[13] advised dynamisation in the 3rd - 5th post operative month if no radiological evidence of union present. In our study 4 patients with Fracture gap were dynamised at 16 -20 weeks. Union achieved after another 3-5 months (3 months to 6 months).

Pagie.A., Whittle[23] in their series concluded bone grafting was necessary for winquest type III and type IV femoral shaft fracture to augment union. It justifies in our series in which winquest type III and type IV fracture (13.3%) were treated with autologous bone grafting.

Brumback et al[6] in his series advocated immediate weight bearing for allowing micro movements at fracture site which augments union. In our study, In all stable fracture partial weight bearing started at the end of 3rd week and full weight bearing allowed at the end of 6th week. For all communited fracture and segmental fracture parital and full weight bearing allowed at 6 week and 12 weeks respectively.

CONCLUSION

This study comprises of mostly Male Patient in their active part of life. So there is a need for quick return to their daily activity.

Intramedullary interlocking nailing for femoral shaft fractures performed worldwide because of load sharing property, Torsional rigidity and rotational stability.

Reamed nailing does not impede fracture healing and helps in easy insertion

Earlier the patients were taken up for surgery easier the reduction and nailing by closed method. Places were imaging facilities are not available, interlocking system with targeting devices are better than free hand technique.

Static locking advisable in severely committed fracture to avoid shortening. If fracture gap present Dynamisation should be performed at 14-16 weeks of post operative period.

We conclude that closed reamed interlocking intra medullary nail in femoral shaft fracture is the treatment of choice because, patient rehabilitation is early, Hospitalisation is short and fracture union is excellent.

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CASE I

NAME	:	Mr.Selvam
AGE/SEX	:	46/m
OCCUPATION	:	Manual labour
I.P.No	:	31124
D.O.A	:	06/05/2008
D.O.S	:	21/05/2008
D.O.D	:	04/07/2008
MODE OF INJURY	:	RTA
DIAGNOSIS	:	Communited Fracture shaft of femur left M/3rd
ASSOCIATED INJURY	:	Nil

SURGERY :

DURATION BETWEEN INJURY AND NAILING	:	6 days
POSITION	:	Supine
OPEN/CLOSED	:	Closed
REAMING	:	Done
BONE GRAFTING	:	None
POST-OP INFECTION	:	Nil

RESULTS				
	Excellent	Good	Fair	Poor
MALALIGNMENT OF FEMUR				
Valgus/varus	_	_	_	_
Antecurvatum/recurvatum	_	_	_	_
Internal rotation	_	_	_	_

External rotation	_	_	_	_
Shortening of femur(cm)	Nil	_	_	_
RANGE OF MOTION OF KNEE				
Flexion	$0\text{-}130^0$	_	_	_
Extension deficit	—	_	_	_
Pain or swelling	NIL	_	_	_

FINAL RESULT: EXCELLENT

CASE II

NAME	:	Mr.SIVA
AGE/SEX	:	40/M
OCCUPATION	:	Painter
I.P.No	:	29102
D.O.A	:	09/06/2008
D.O.S	:	21/06/2008
D.O.D	:	30/06/2008
MODE OF INJURY	:	RTA
DIAGNOSIS	:	Fracture shaft of femur m/3rd right side
ASSOCIATED INJURY	:	Nil
SURGERY:		
DURATION BETWEEN INJURY AND NAILING	:	7 days
POSITION	:	Supine
OPEN/CLOSED	:	Closed
REAMING	:	Done
BONE GRAFTING	:	Not done
POST-OP INFECTION	:	Nil

RESULTS				
	Excellent	Good	Fair	Poor
MALALIGNMENT OF FEMUR				
Valgus/varus	_	_	_	_
Antecurvatum/recurvatum	_	_	_	_

Internal rotation	_	_	_	_
External rotation	_	_	_	_
Shortening of femur(cm)	0.5cm	_	_	_
RANGE OF MOTION OF KNEE				
Flexion	$0\text{-}130^0$	_	_	_
Extension deficit	—	_	_	_
Pain or swelling	Nil	_	_	_

FINAL RESULT: EXCELLENT

CASE III

NAME	:	Mr.Panner selvam
AGE/SEX	:	65/m
OCCUPATION	:	Manual labour
I.P.No	:	55696
D.O.A	:	18/11/2009
D.O.S	:	06/12/2008
D.O.D	:	22/12/2008
MODE OF INJURY	:	RTA
DIAGNOSIS	:	Communited Fracture shaft of femur L/3rd Left side.
ASSOCIATED INJURY	:	Nil
SURGERY	**:**	

DURATION BETWEEN INJURY AND NAILING : 12 days

POSITION : Supine

OPEN/CLOSED : closed

REAMING : Done

BONE GRAFTING : Not done

POST-OP INFECTION : Nil

RESULTS				
	Excellent	Good	Fair	Poor
MALALIGNMENT OF FEMUR				
Valgus/varus	_	_	_	_
Antecurvatum/recurvatum	_	_	_	_
Internal rotation	_	_	_	-

External rotation	_	_	_	_
Shortening of femur(cm)	-	_	_	_
RANGE OF MOTION OF KNEE				
Flexion	135^0	_	_	_
Extension deficit	_	_	_	_
Pain or swelling	Nil	_	_	_

FINAL RESULT : Excellent

CASE IV

NAME	:	Mr.Manoj kumar
AGE/SEX	:	41/m
OCCUPATION	:	Mannual labour
I.P.No	:	2126 1
D.O.A	:	05/09/2008
D.O.S	:	15/ 09/2008
D.O.D	:	21/09/2008
MODE OF INJURY	:	RTA
DIAGNOSIS	:	Fracture shaft of femur M/3rd
ASSOCIATED INJURY	:	Nil

SURGERY:

DURATION BETWEEN INJURY AND NAILING	:	16 days
POSITION	:	Lateral
OPEN/CLOSED	:	Open
REAMING	:	Done
BONE GRAFTING	:	Not done
POST-OP INFECTION	:	Nil

RESULTS				
	Excellent	Good	Fair	Poor
MALALIGNMENT OF FEMUR				
Valgus/varus	_	_	_	_
Antecurvatum/recurvatum	_	_	_	_
Internal rotation	_	_	_	_

External rotation	_	_	_	_
Shortening of femur(cm)	Nil	_	_	_
RANGE OF MOTION OF KNEE				
Flexion	—	—	0-90	_
Extension deficit	_	10^0	_	_
Pain or swelling	_	NIL	_	_

FINAL RESULT : GOOD

CASE V

NAME : Mr.Gopal

AGE/SEX : 20/m

OCCUPATION : Student

I.P.No : 43580

D.O.A : 01/08/2008

D.O.S : 10/08/2008

D.O.D : 20/08/2008

MODE OF INJURY : RTA

DIAGNOSIS : Fracture shaft of femur
Lower third left side

ASSOCIATED INJURY : Nil

SURGERY:

DURATION BETWEEN
INJURY AND NAILING : 9 days

POSITION : Lateral

OPEN/CLOSED : Open

REAMING : Done

BONE GRAFTING : Not done

POST-OP INFECTION : Nil

RESULTS				
	Excellent	Good	Fair	Poor
MALALIGNMENT OF FEMUR				
Varus	_	_	_	15^0
Antecurvatum/recurvatum	_	_	_	_
Internal rotation	_	_	_	15^0

External rotation	_	_	_	_
Shortening of femur(cm)	1cm	_	_	_
RANGE OF MOTION OF KNEE				
Flexion	_	—	—	100^0
Extension deficit	_	—	_	20^0
Pain or swelling	_	_	_	PRESENT

FINAL RESULT: POOR

PROFORMA

NAME : AGE/SEX :
OCCUPATION :
I.P.No :
D.O.A : D.O.S:
D.O.D :
MODE OF INJURY :
DIAGNOSIS :
ASSOCIATED INJURY :
SURGERY :
DURATION OF INJURY AND NAILING
POSITION :
OPEN/CLOSED :
REAMING :
BONE GRAFTING:
UNION TIME :

POST-OP INFECTION :

RESULTS				
	Excellent	Good	Fair	Poor
MALALIGNMENT OF FEMUR				
Valgus/varus				
Antecurvatum/recurvatum				
Internal rotation				
External rotation				
Shortening of femur(cm)				
RANGE OF MOTION OF KNEE				

Flexion				
Extension deficit				
Pain or swelling				

FINAL RESULT:

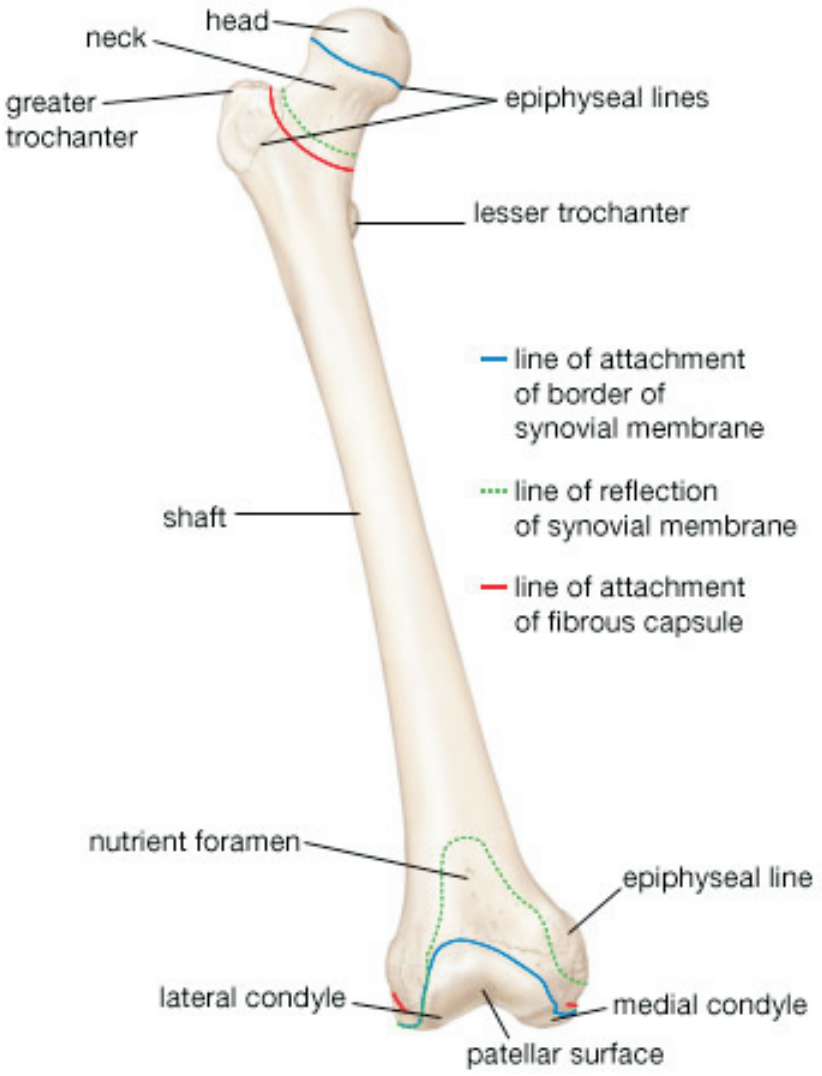
KEY TO MASTER CHART

S. NO.	Serial number
MOI	Mode of injury
WHC	Winquist hansen classification
OP	Open
CL	Closed
ILN	Injury
DBIS	Duration between injury and surgery
IMN	Intramedullay nailing
SL	Static locking
DL	Dynamic lockng
BW	Bone graft
INF	Infection
MOF	Mal alignment of femur
IR	Internal rotation
ER	External rotation
RAD U W	Radialogical union in weeks
FFH	Fall from height
FR	Final result
RTA	Road traffic accident
N	Nil
BG	Bone grafting
BGL	Bone Grafting Later
DLL	Dynamisation

MASTER CHART

S. NO.	NAME	AGE	SEX	MOI	WHC (Type)	SIDE	OPEN/ CLOSED INJ	DOS	DBIS	OP/CL INJURY	REAMED	ST/DY LOCKING	BG	PO INF	RAD U W	IR	ER	SHORTENING	KNEE FLEXION	EX. DEF	FINAL RESULT
1	Kuppal	40	F	RTA	I	R	CL	17.04.07	8	OP	Reamed	SL	ND	N	32	--	--	--	0-135°	---	Excellent
2	Saravanan	20	M	RTA	II	R	CL	03.05.07	7	OP	Reamed	SL	ND	N	18	--	5°	--	0-130°	---	Excellent
3	Sundarammal	50	F	RTA	II	R	CL	26.04.07	20	OP	Reamed	DLL	ND	N	34	--	--	--	0-135°	---	Excellent
4	Mohammed Yasin	48	M	RTA	I	R	CL	22.05.07	20	OP	Reamed	DL	ND	N	24	--	--	--	0-120°	---	Excellent
5	Kannan	19	M	RTA	I	R	CL	22.05.07	22	CL	Reamed	SL	ND	N	20	--	--	--	0-135°	---	Excellent
6	Siva	38	M	RTA	III	L	CL	24.05.07	7	CL	Reamed	SL	BGL	N	30	5°	--	--	0-135°	---	Excellent
7	Chelladurai	49	M	RTA	II	L	CL	12.06.07	8	CL	Reamed	SL	ND	N	24	--	5°	--	0-130°	---	Excellent
8	Parthiban	23	M	RTA	IV	L	CL	19.06.07	22	OP	Reamed	SL	BG	N	34	--	--	1 cm	0-110°	---	Fair
9	Gnanambal	57	F	RTA	II	L	OP	26.07.07	6	CL	Unreamed	SL	ND	N	20	--	--	--	0-135°	---	Excellent
10	Ramasamy	50	M	RTA	I	R	CL	05.08.07	18	OP	Reamed	SL	ND	INF	32	--	--	--	0-135°	---	Excellent
11	Selvam	43	M	RTA	II	L	CL	21.09.07	15	CL	Reamed	SL	ND	N	24	--	--	--	0-135°	---	Excellent
12	Sivaraj	35	M	RTA	I	R	CL	21.10.07	12	CL	Reamed	SL	ND	N	20	--	--	--	0-135°	---	Excellent
13	Gopal	20	M	RTA	I	R	CL	10.12.07	19	OP	Reamed	SL	ND	N	NU	--	--	--	0-100°	20°	Poor
14	Manojkumar	41	M	RTA	I	R	CL	15.02.07	16	OP	Reamed	SL	ND	N	36	--	--	--	0-90°	10°	Fair
15	Karuppusamy	21	M	RTA	III	R	CL	05.01.08	17	OP	Reamed	SL	BG	N	28	--	5°	0 cm	0-120°	---	Good
16	Madan	32	M	RTA	IV	L	CL	09.01.09	9	CL	Reamed	SL	ND	N	26	--	--	1 cm	0-120°	---	Excellent
17	Paramasivam	29	M	RTA	II	R	CL	12.01.08	12	OP	Reamed	SL	ND	N	16	--	--	--	0-135°	---	Excellent
18	Ramasamy	50	M	RTA	I	L	CL	17.01.08	16	OP	Reamed	DLL	ND	N	30	--	--	--	0-120°	---	Excellent
19	Paneerselvam	46	M	RTA	IV	L	CL	24.02.08	31	OP	Reamed	SL	BG	N	22	--	--	--	0-120°	---	Good
20	Selvakumar	19	M	RTA	I	R	CL	31.03.08	14	CL	Reamed	SL	ND	N	16	--	--	--	0-135°	---	Excellent
21	Murugan	30	M	RTA	II	R	CL	14.03.08	13	OP	Reamed	SL	ND	N	24	--	--	--	0-135°	---	Excellent
22	Seethammal	60	F	RTA	II	R	CL	09.04.08	15	OP	Reamed	SL	ND	N	20	--	--	--	0-130°	---	Excellent
23	Chinnakalai	50	M	RTA	I	R	CL	28.04.09	6	CL	Reamed	SL	ND	N	28	--	--	--	0-120°	---	Good
24	Shanthi	20	F	RTA	I	L	CL	16.05.08	12	OP	Reamed	SL	ND	N	22	--	--	--	0-135°	---	Excellent
25	Palaniyammal	60	F	RTA	II	R	CL	17.05.08	24	OP	Reamed	SL	ND	N	30	--	--	--	0-100°	---	Good
26	Nagarajan	20	M	RTA	I	R	CL	13.05.08	18	OP	Reamed	SL	ND	N	28	--	--	--	0-135°	---	Excellent
27	Nataraj	24	M	RTA	II	L	CL	15.05.08	16	OP	Reamed	SL	ND	N	20	--	--	--	0-130°	---	Excellent
28	Ravi	38	M	RTA	I	L	CL	18.05.08	13	OP	Reamed	SL	ND	N	26	--	--	--	0-135°	---	Excellent
29	Manickam	39	M	RTA	I	R	CL	14.05.08	8	CL	Reamed	SL	ND	N	20	--	--	--	0-135°	---	Excellent
30	Krishnaveni	35	F	RTA	I	L	CL	21.05.08	7	CL	Reamed	DLL	ND	N	26	--	--	--	0-135°	---	Excellent
31	Usha	43	F	RTA	IV	R	CL	28.05.08	18	OP	Reamed	SL	BG	N	30	10°	10°	1 cm	0-120°	---	Good
32	Muthu	32	M	RTA	I	R	CL	28.06.08	8	CL	Reamed	DLL	ND	N	28	--	--	--	0-135°	---	Excellent
33	Subbaiya	70	M	RTA	II	R	CL	02.06.08	23	OP	Reamed	SL	ND	N	30	--	--	--	0-130°	---	Excellent
34	Andal	40	F	RTA	II	R	CL	07.06.08	7	CL	Reamed	SL	ND	N	18	--	--	--	0-135°	---	Excellent
35	Patric	45	M	RTA	IV	R	CL	07.06.08	10	OP	Reamed	SL	ND	N	NU	10°	--	2 cm	0-100°	---	Poor
36	Palaniyammal	65	F	RTA	I	R	CL	09.06.08	12	OP	Reamed	SL	ND	N	30	--	--	--	0-135°	---	Excellent
37	Chinnasamy	70	M	RTA	II	R	CL	11.06.08	17	OP	Reamed	SL	ND	N	30	--	--	--	0-120°	---	Good
38	Vinodkumar	35	M	RTA	III	R	CL	12.06.08	7	CL	Reamed	SL	BGL	N	38	--	--	1 cm	0-120°	---	Good
39	Sadayandi	30	M	FFH	I	L	CL	18.06.08	9	CL	Reamed	SL	ND	N	18	--	--	--	0-135°	---	Excellent
40	Murugan	26	M	RTA	I	R	CL	10.06.08	19	OP	Reamed	DL	ND	N	18	--	--	--	0-135°	---	Excellent
41	Ramesh	35	M	RTA	I	R	CL	28.06.08	15	OP	Reamed	SL	ND	N	20	--	--	--	0-130°	---	Excellent
42	Leo Selvam	40	M	RTA	I	R	CL	05.07.08	17	OP	Reamed	SL	ND	N	28	--	--	--	0-130°	---	Excellent
43	Kumar	38	M	RTA	I	R	CL	17.07.08	19	OP	Reamed	SL	ND	N	20	--	--	--	0-135°	---	Excellent
44	Lakshmi	60	F	RTA	III	R	CL	09.07.08	18	OP	Reamed	SL	BG	N	30	5°	--	--	0-130°	---	Excellent
45	Arulnathan	29	M	RTA	II	L	CL	12.07.08	6	CL	Reamed	SL	ND	N	12	--	--	--	0-130°	---	Excellent
46	Anbu	28	M	RTA	II	L	CL	25.07.08	14	OP	Reamed	SL	ND	N	16	--	--	--	0-135°	---	Excellent
47	Sathyamoorthy	40	M	FFH	I	R	CL	28.07.08	4	CL	Reamed	SL	ND	N	16	--	--	--	0-135°	---	Excellent
48	Abdulkadar	76	M	RTA	III	L	CL	31.07.08	19	OP	Reamed	SL	BG	N	28	0	--	0.5 cm	0-130°	---	Excellent
49	Anandkumar	52	M	RTA	II	L	CL	04.08.08	12	OP	Reamed	SL	ND	N	36	5°	--	--	0-130°	---	Excellent

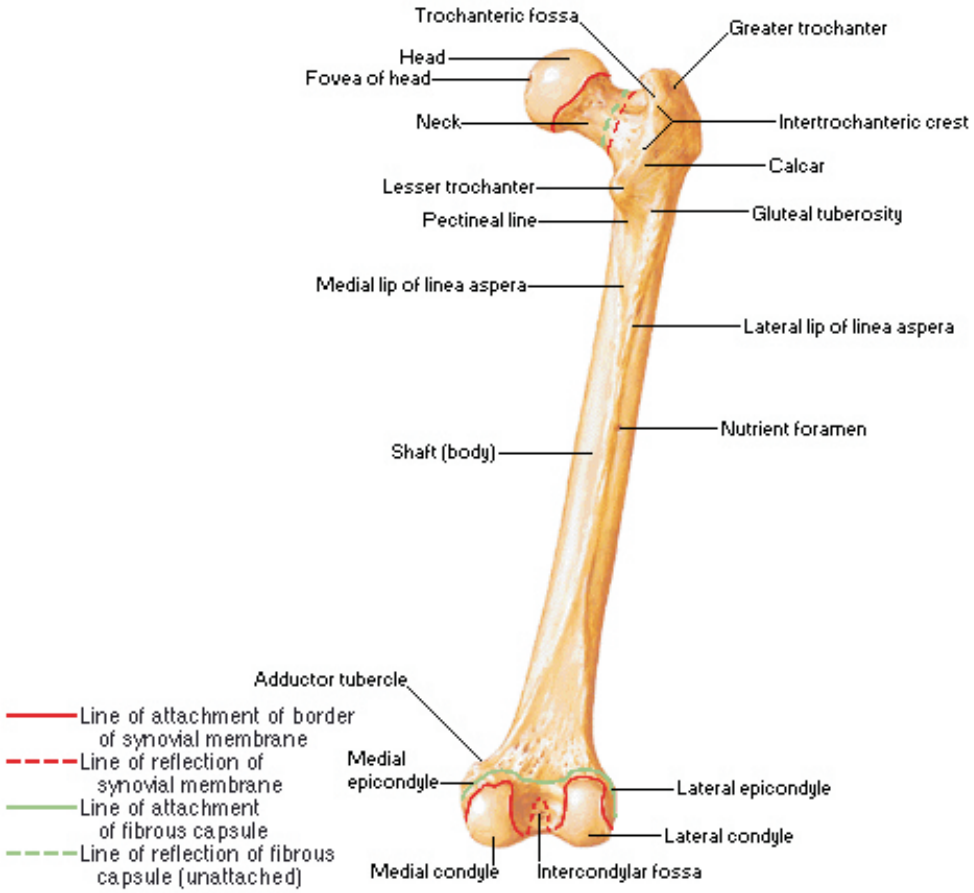
50	Subramani	37	M	RTA	II	L	CL	11.08.08	3	CL	Reamed	SL	ND	N	14	--	--	--	0-130°	---	Excellent
51	Barani	48	M	RTA	I	R	CL	09.08.08	6	OP	Reamed	SL	ND	N	20	--	--	--	0-130°	---	Excellent
52	Kumaran	62	M	RTA	II	R	OP	14.08.08	14	OP	Unreamed	SL	ND	INF	26	--	--	--	0-135°	---	Good
53	Joseph	55	M	RTA	I	L	CL	16.08.09	13	OP	Reamed	SL	ND	N	24	--	--	--	0-130°	---	Excellent
54	Velathal	55	F	RTA	II	R	CL	22.08.08	16	OP	Reamed	SL	ND	N	20	--	--	--	0-135°	---	Excellent
55	Rani	23	F	RTA	I	L	CL	11.09.08	6	OP	Reamed	SL	ND	N	18	5°	--	--	0-130°	---	Excellent
56	Nagaraj	29	M	RTA	I	L	CL	20.09.08	18	OP	Reamed	SL	ND	N	20	--	--	--	0-130°	---	Excellent
57	Shanthakumar	35	M	RTA	I	R	CL	22.09.08	8	CL	Reamed	SL	ND	N	18	--	--	--	0-135°	---	Excellent
58	Subbaiyan	46	M	RTA	I	R	CL	25.09.08	8	CL	Reamed	SL	ND	N	22	--	--	--	0-130°	---	Excellent
59	Pappathi	55	F	RTA	I	L	CL	27.09.08	17	OP	Reamed	SL	ND	N	24	--	--	--	0-135°	---	Excellent
60	Samynathan	26	M	RTA	I	R	CL	29.09.08	6	OP	Reamed	SL	ND	N	20	--	--	--	0-130°	---	Excellent

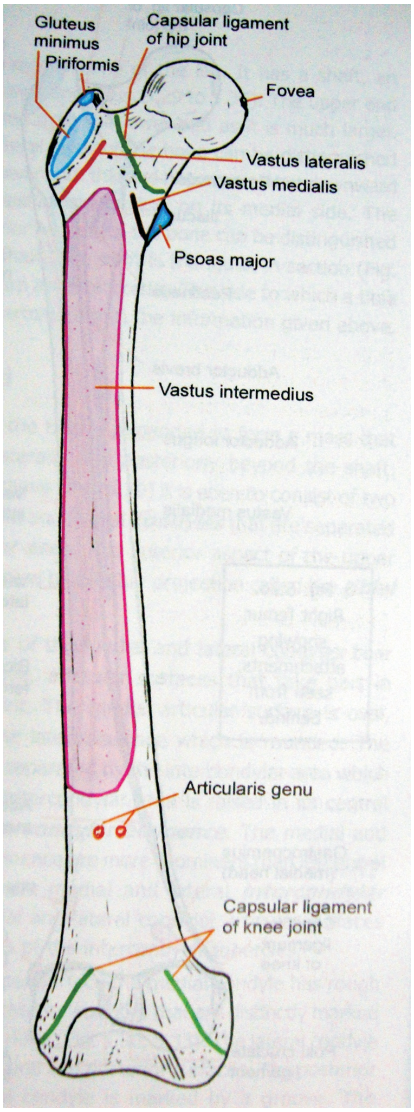


RIGHT FEMUR ANTEIOR ASPECT

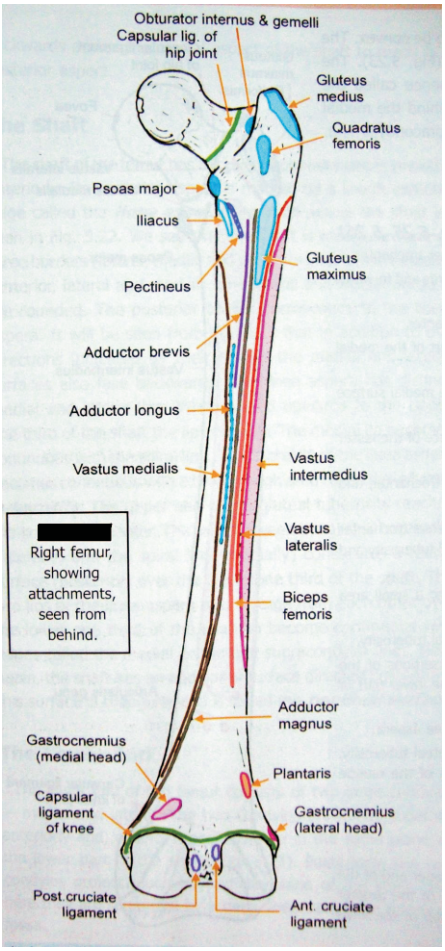
Femur

Posterior View

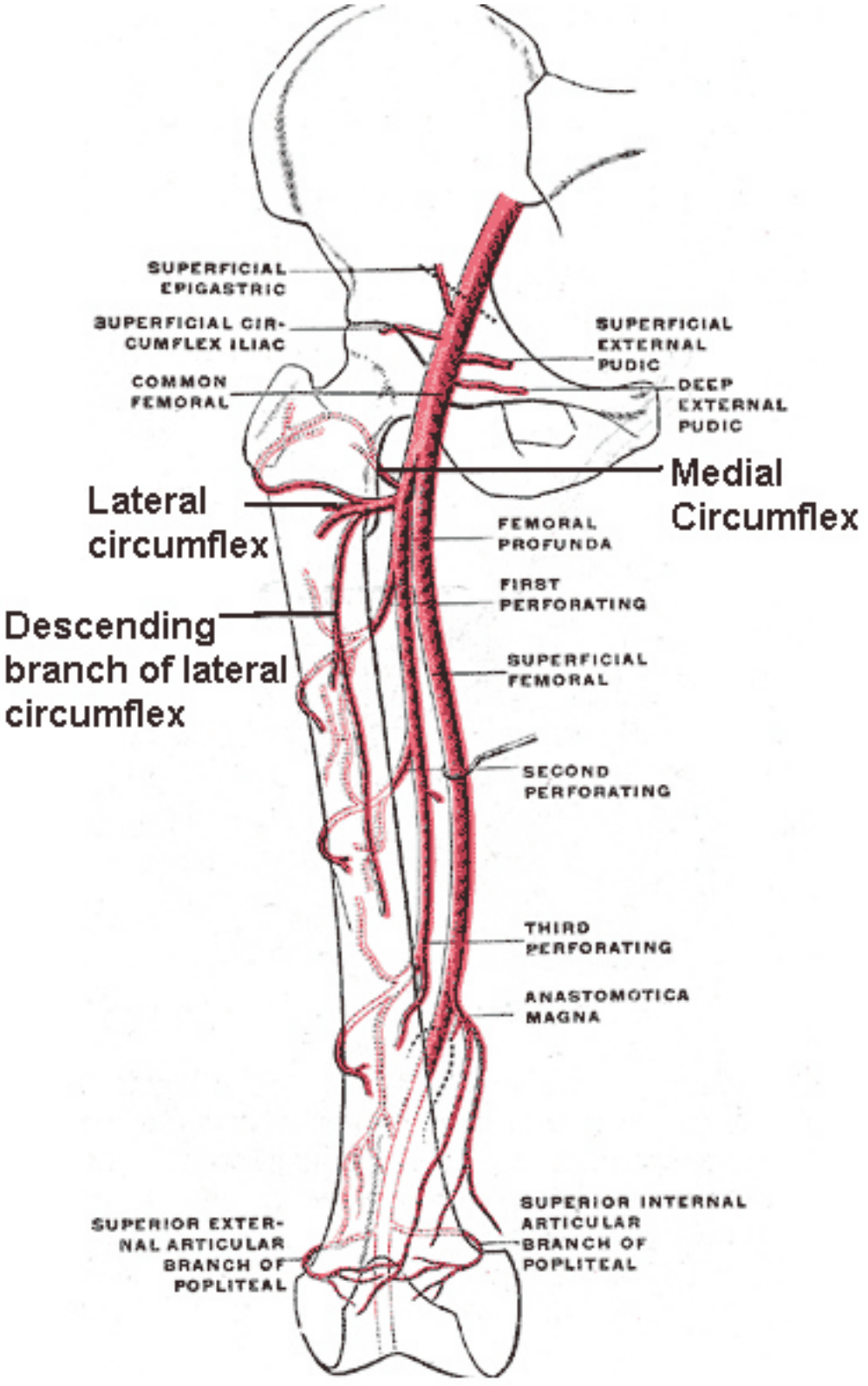




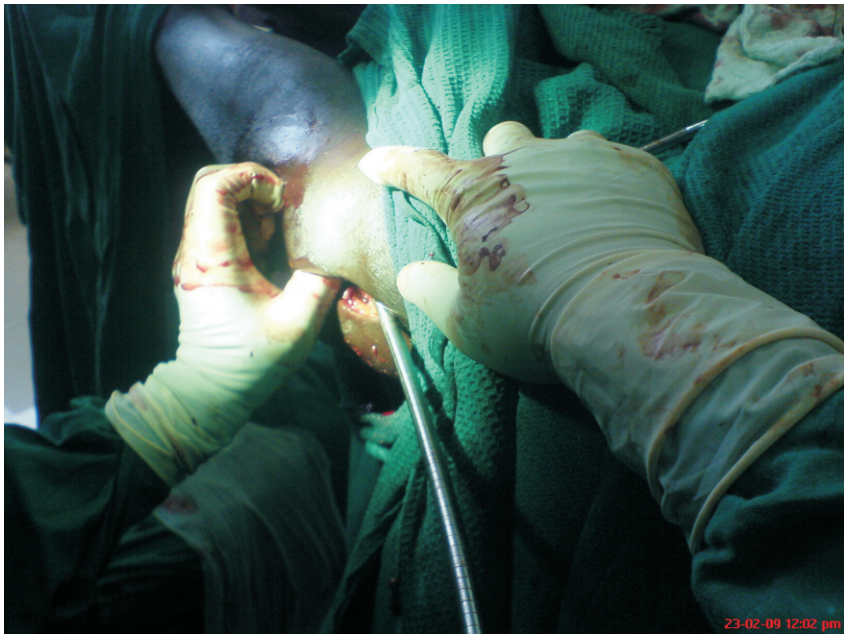
FIGHT FEMUR MUSCLE ATTACHMENTS IN FRONT



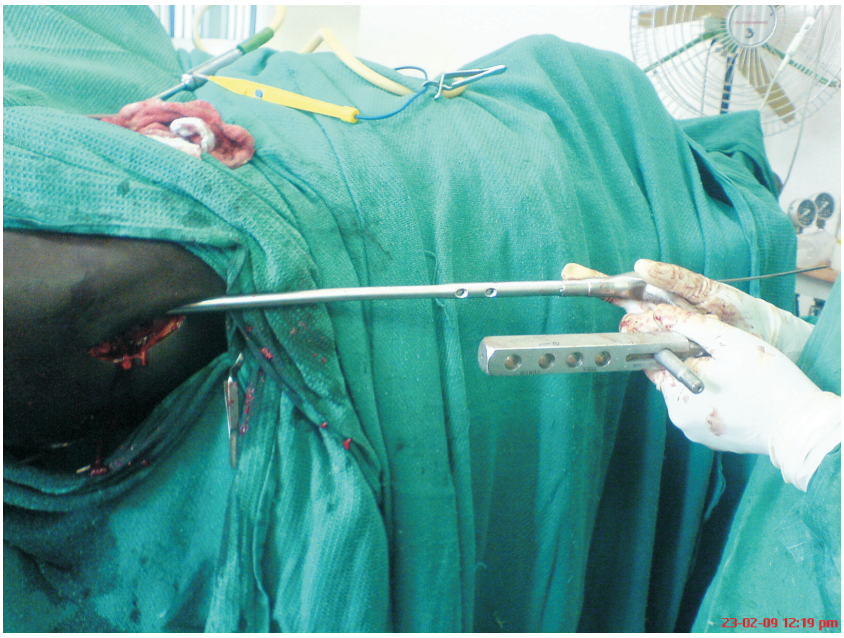
RIGHT FEMUR MUSCLE ATTACHMENTS FROM BEHIND



VASCULAR SUPPLY OF FEMUR



REAMING OF MEDULLARY CANAL BY FLEXIBLE REAMER



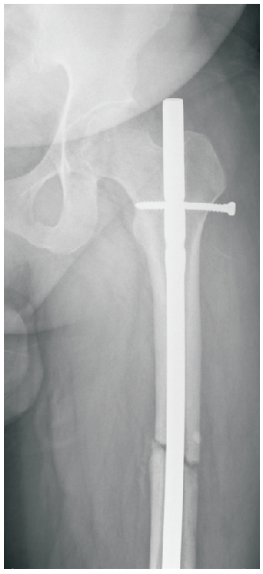
NAIL INSERTION WITH JIG

DISTAL LOCKING

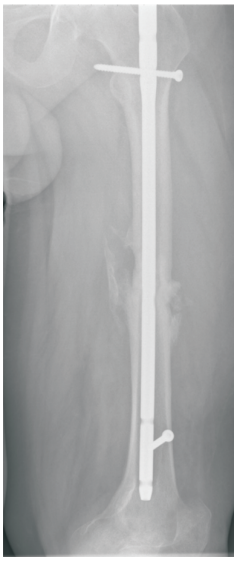
CASE - 1

PRE-OP

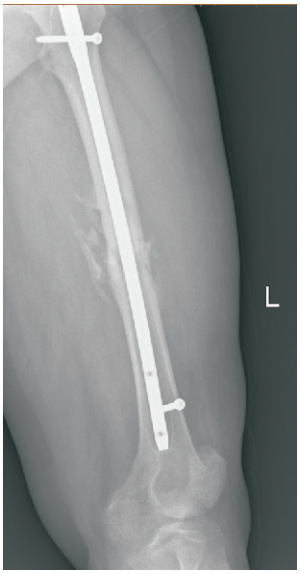
PRE-OP



IMMEDIATE POST-OP



SEVEN MONTH FOLLOW UP



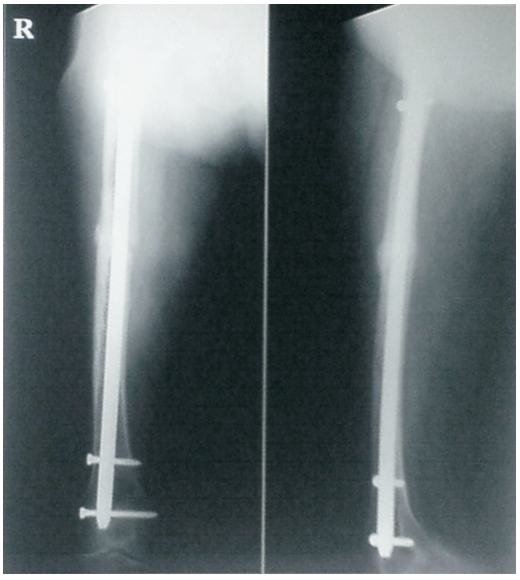
ONE YEAR FOLLOW UP

CASE - II

PRE-OP

IMMEDIATE POST-OP

IMMEDIATE POST-OP

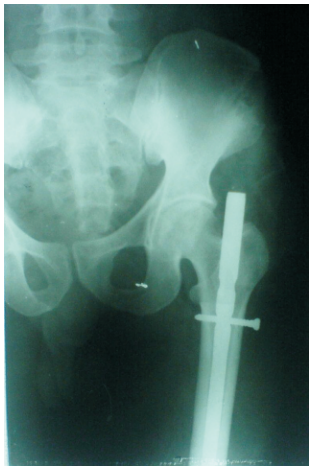


ONE YEAR FOLLOW UP

CASE - III

PRE-OP

PRE-OP



IMMEDIATE POST-OP

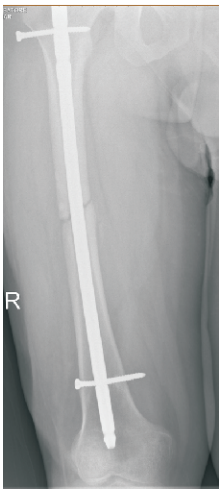
IMMEDIATE POST-OP

EIGHT MONTHS FOLLOWUP

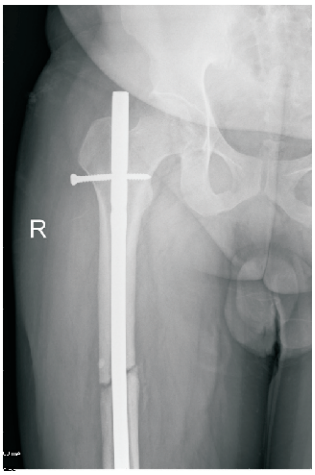
CASE - IV

PRE-OP

PRE-OP

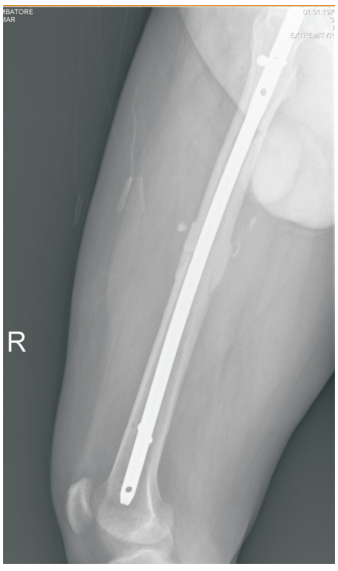


IMMEDIATE POST-OP



IMMEDIATE POST-OP

ONE YEAR FOLLOWUP



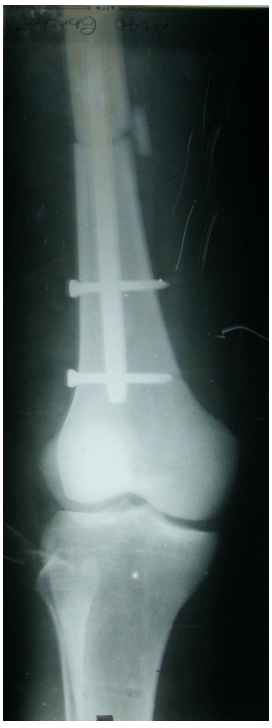
ONE YEAR FOLLOWUP

CASE - V

PRE-OP

PRE-OP

IMMEDIATE POST-OP



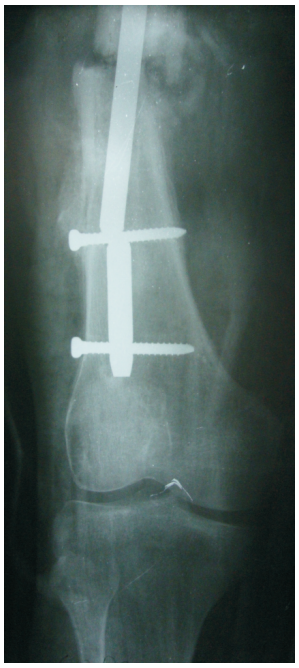
IMMEDIATE POST-OP

CASE - V

FIVE MONTH FOLLOW UP

FIVE MONTH FOLLOW UP

IMMEDIATE DYNAMISATION



FOUR MONTHS AFTER DYNAMISATION

IMMEDIATE DYNAMISATION